

## **M31 XYZ Probing Macro and M6 Manual Tool Change Macro Documentation (v2.00)**

**Description:** This documents a collection of UCCNC macros which work together to:

- Provide multiple probing methods for zeroing the XYZ workspace, including:
  - Surface Probing: Simple top down probing for Z only
  - Hole Probing: XYZ Corner Probing using a plate-aligned hole
  - Edge Probing: XYZ Corner Probing using a square plate
- Enable/Maintain automatic Tool Length compensation during manual Tool Changes
- Provide multiple methods to automatically restore a probed workspace coordinate system following a crash, power outage, etc, including:
  - OLD Bit Coordinate Restoration: Motionless coordinate restoration if the Tool Bit has not been disturbed
  - NEW Bit Coordinate Restoration: Coordinate restoration if the tool bit has been replaced

### **Macros Provided:**

- M31 XYZ Probing Macro: This is the “master” macro which establishes/maintains all configuration and operational settings for the associated family of macro’s. This macro performs the initial XYZ work surface probing to zero the Workspace Coordinate System (WCS). No other macro in this family will function without the execution of this macro. M31 should be ALWAYS be used for initial workspace probing/zeroing if any of the other macros are to be subsequently executed. DO NOT attempt to execute any of the other family macros if the M31 macro was not used to zero the workspace.
- M6 Tool Change Macro: This macro supports ongoing manual tool changes and will automatically adjust the WCS to compensate for differences in tool length.
- OLD Bit Coordinate Recovery Macro: This macro can be used to automatically recover a crashed WCS (Power Outage, etc) as long as the working tool bit has not been disturbed. No gantry motion is required.
- NEW Bit Coordinate Recovery Macro: This macro can be used to automatically recover a crashed WCS (Power Outage, etc) even if the tool bit has been replaced or adjusted in the collet. This macro will reprobe a Fixed Plate to re-establish a coherent WCS Z axis.

### **Automatic tool length compensation requires TWO probing plates:**

- MOBILE Plate: A “Mobile” plate is probed to initially establish a zero’ed WCS relative to the work surface. This plate is manually positioned as required to probe the work surface at the start of each job. The Mobile Plate is only required to be used during the initial XYZ probing sequence (M31). M31 supports Mobile Plates with a centering hole as well as simple rectangular Mobile Plates.

- FIXED Plate: A “Fixed” plate is probed to establish a repeatable baseline in order to maintain the WCS Z axis. The initial XYZ probe event (M31) establishes and records the associated “offset” between the current work surface (WCS Z Zero) and the Machine Z Coordinate (MCS) of the Fixed Plate. Tool change operations (supported by M6), then continue to use the Fixed Plate to adjust the WCS Z coordinate to automatically compensate for differences in tool length. The Fixed Plate is required by both the initial XYZ Probing Macro (M31) and the ongoing Manual Tool Change Macro (M6). Fixed Plates should be attached to the bed of the machine (to serve as a reliable/repeatable reference point) and in a dedicated position for automatic location.

### **Macro Family Configuration (Settings):**

- All configuration and operational settings for the entire family of Macro’s is maintained within a single GUI screen integrated in the M31 XYZ Probing Macro. No editing of individual macro’s is needed (or desired).
- Configuration parameters and dynamic data are maintained in a private section of the currently active UCCNC profile (“[XYZProbeData]”). As such, multiple machines, using different profiles, will be able to maintain completely independent probing configurations.
- The M31 Configuration GUI will automatically save and reload the configuration settings used by the most recent probing activity.
- The M6 Tool Change Macro will recall the baseline “Plate Offset” (most recently established established by M31) to automatically adjust the WCS as required to support tools of different lengths.

### **Probing Guidelines (M31):**

- Homing: In order to establish a safe and repeatable Machine Coordinate System (MCS), the machine must be homed prior to using any of this family of macros. The ability to accurately recover an established WCS following a crash or power outage will be somewhat dependent on the precision and repeatability of the machine end stops or limit switches used during the homing operation.
- SafeZ: It is generally assumed that the homing operation will result in a zero’ed MCS at the upward most limit of axis travel. While alternative configurations may be acceptable (“SafeZ” is user configurable), this has not been tested.
- Orientation: Currently, all “corner” probing operations will assume the WCS zero location is to be established at the “front, left” corner of the work piece (in the X negative and Y negative direction) and at the surface of the work piece.
- Probing Movement: ALL Probing operations, in all axis’, are performed in two stages. First a fast probing motion is performed to find the “general” location of the associated surface. Then the probe is retracted slightly, and a second slower probing motion is performed for improved accuracy. Corner probing motions are always initiated in the direction to least likely cause damage if there is a problem with the probing circuit (or if a probing lead was not properly

connected). IOW: The initial probe motion would push the probing block off the work surface rather than into the work piece.

- Probe Conductivity: The operator may optionally configure to validate electrical conductivity between the plate and probe prior to the probing operation. If so, the activity will not continue until a probe contact is confirmed by UCCNC.
- Probing Delay: A configurable delay is supported to allow time for the operator to manually stabilize the Mobile Plate immediately before actual probing movement is initiated.
- Probe Leads: The operator is prompted to attach and detach (as appropriate) the Magnetic Probe Lead or Clip when directly over the associated Mobile Plate or Fixed Plate. For the sake of brevity, these prompts are not specifically mentioned in the description of the associated probing methodologies
- Probing Bit: While not always possible or practical, a perfectly cylindrical probing bit is suggested for maximum precision. Flutes on cutting tools/bits can introduce variances in probing activities.
- Dust Shoes: Both M31 and M6 support automatic operator prompts for the removal and reinstallation of Dust Shoes if so configured.

#### **Initial XYZ Probing Methodology (M31 requires both the Mobile Plate and the Fixed Plate):**

- SURFACE Probing: This is a simple probing method which only probes the Z axis. The operator can choose to accept the WCS X/Y alignment at the time of the probe operation, or configure such that the WCS X/Y is zero'ed during the probing location. The operator should position the probing bit above the Mobile Plate (or vice-versa) to perform the operation. The motion will proceed as follows:
  - Probe the surface of the Mobile Plate (Z-)
  - Retract to SafeZ
  - Reposition to the location of the Fixed Plate
  - Probe the surface of the Fixed Plate (Z-)
  - Retract to SafeZ
  - Reposition to the designated "Tool Change" position
- HOLE Probing: XYZ Corner Probing using a plate-aligned hole should be initiated with the probing bit lowered down into the approximate center of the probing hole. It should be positioned below the top surface of the plate but not so far down as to touch the work surface. The motion will proceed as follows:
  - Probe the front inside of the Mobile Plate hole (Y-)
  - Probe the rear inside of the Mobile Plate hole (Y+)
  - Probe the left inside of the Mobile Plate hole (X-)
  - Probe the right inside of the Mobile Plate hole (X+)
  - (The operator may optionally configure for a second, potentially more precise, Y-axis probe (Y-, Y+) to take advantage of a "perfectly" centered X-axis)
  - Retract the probe (2 x Plate Thickness)

- Reposition over the Mobile Plate
  - Probe the surface of the Mobile Plate (Z-)
  - Retract to SafeZ
  - Reposition to the location of the Fixed Plate
  - Probe the surface of the Fixed Plate (Z-)
  - Retract to SafeZ
  - Reposition to the designated “Tool Change” position
- EDGE Probing: XYZ Corner Probing using a square plate should be initiated with the probing bit located just off the right edge of the plate at its approximate centerline. It should be positioned below the top surface of the plate but not so far down as to touch the work surface. If using a very large diameter probing bit, the bit should be positioned such that its forward edge does not protrude beyond the front edge of the plate. The motion will proceed as follows:
    - Probe the right side of the Mobile Plate (X-)
    - Reposition to the rear of the Mobile Plate (Y+, X-)
    - Probe the back side of the Mobile Plate (Y-)
    - Retract the probe (2 x Plate Thickness)
    - Reposition over the Mobile Plate
    - Probe the surface of the Mobile Plate (Z-)
    - Retract to SafeZ
    - Reposition to the location of the Fixed Plate
    - Probe the surface of the Fixed Plate (Z-)
    - Retract to SafeZ
    - Reposition to the designated “Tool Change” position

**Tool Change Methodology** (M6 only requires the Fixed Plate):

- When a tool change is requested, the M6 macro will:
  - Stop the Spindle
  - Move to the designated Tool Change position
  - Solicit a manual Tool Change
  - Reposition to the location of the Fixed Plate
  - Probe the surface of the Fixed Plate (Z-)
  - Retract to SafeZ
  - Reposition to the designated “Tool Change” position
- UCCNC will then continue job processing with the automatically recalibrated WCS (Z Axis)

**UCCNC Considerations:**

- UCCNC must be specifically configured (in Settings) to run the M6 Macro when an M6 directive (Tool Change request) is encountered. The default configuration is to simply ignore Tool Change requests.
- The PROBE Button on the UCCNC screen will automatically run any macro named “M31.txt”. It is suggested that the default M31.txt file be preserved/renamed before copying this M31 macro into place.

- The M6 macro may be manually tested by simply entering “M6 T1” at the UCCNC MDI. (The “T1” Tool ID parameter will basically be ignored, but may be required depending on the configuration). It is suggested that the default M6.txt file be preserved/renamed before copying this M6 macro into place.

### **Design Software Considerations (Post-Processor):**

- Optimally, Design Software should be configured to include “multiple tool paths” in a single file. This will allow entire projects, requiring multiple tools, to be stored in a single job file.
- Optimally, Design Software Post-Processors should be selected (or configured) to support Automatic Tool Change (“ATC”) operations. Typically, this is no more complicated than the insertion of a single line of code like “M6 T1” into the job file (where “M6” is the tool change directive and “T1” is the tool number). A pre-configured Post-Processor for Vectric VCarve is provided with this family of macros.
- Otherwise, in the event that Design Software does not support multiple tool paths in a single file, or a Post-Processor does not support Automatic Tool Changes, it is still possible to take advantage of the M6 macro’s capability to automatically compensate for tool length changes between different tool paths of the same project. Simply run the M6 macro manually by entering “M6 T1” at the UCCNC MDI between job files (and after manually changing the tool bit as needed). As long as the work piece has not moved or been changed, M6 will recalibrate the WCS for the new tool length without requiring any manual re-probing activity (M31 does NOT need to be re-run).
- Note: The “T1” tool number is only used by the M6 macro to confirm that the designated tool is NOT already in use (or the tool change will be ignored). The operator may optionally configure the M6 macro to simply ignore the tool parameter altogether.

### **Configuration Parameters (GUI):** All units are “machine” units

- Probe Method (Surface, Hole, or Edge): The probing method to be used. See descriptions above. (M31)
- Mobile Plate Characteristics (Used by M31 Only):
  - Shelf Thickness: Touch Plates with corner detection typically have a recess to align the plate to the work piece. This is the thickness of that recess (shelf).
  - Total Thickness: Touch Plates with corner detection typically have a “curb” (lip) which drops below the recess (shelf) to align the plate against the edge/corner of the work piece. This is the total thickness of the entire plate (including the lip/curb). (Surface Probe optionally)
  - Hole Diameter: If your Touch Plate includes a centering hole, this is the diameter of that hole. (Hole Probe only).
  - Size: As Touch Plates are typically dimensionally symmetrical (length by width) for flexibility, this is that dimension (length or width). (Edge Probe only)

- Lip Width: This is the width (NOT height) of the curb/lip on a corner detection Touch Plate. (Edge Probe only)
- Fixed Plate Location (Used by Both M31 and M6):
  - X: X Machine Coordinate of the center of the Fixed Plate
  - Y: Y Machine Coordinate of the center of the Fixed Plate
- Probing Bit Characteristics (M31 Edge Probe only):
  - Bit Diameter: The diameter of the probing bit.
- Tool Change Location (M31/M6 parking location for manual Tool Changes):
  - X: X Machine Coordinate
  - Y: Y Machine Coordinate
  - Z: Z Machine Coordinate
- Tuning Parameters:
  - SafeZ: The Machine Z Coordinate to which the spindle should be retracted prior to a “Safe” move. (M31 and M6)
  - Retract Distance: The minimal distance the probe bit should be retracted during probe operations between Fast and Slow probing actions. This effects probing operations in all axis’. (M31 and M6)
  - Coarse Rate: The feed rate for the initial Quick probing movement. (M31 and M6)
  - Fine Rate: The feed rate for the final Slow/Accurate probing movement. (M31 and M6)
  - Z Max Probe Distance: The maximum Z travel to allow for all probes of the Z axis. (M31 and M6)
  - OK Delay: The number of seconds to delay before the M31 probe action actually begins moving (after hitting “OK”). This provides a bit of time to hold and stabilize the Mobile Plate if so desired. (M31 only)
- Behavioral Parameters:
  - Dust Shoe: Setting this to TRUE will enable additional prompts to remove/install a Dust Shoe as needed. (M31 and M6)
  - Auto Home: Setting this to TRUE will direct M31 to automatically perform a homing operation if the machine has NOT already been homed. This will allow the M31 macro to provide more thorough machine initialization. (M31 only)

- Confirm Probe Continuity: Setting this to TRUE will confirm electrical conductivity between the probing bit and the Mobile Plate immediately before spindle movement. The macro will wait for UCCNC to confirm probe conductivity before proceeding to the final “OK” message. (M31 only)
- Do 2<sup>nd</sup> Y Pass: Setting this to TRUE will run an additional probing pass on the Y axis after the X axis has been accurately centered. This can marginally improve probing accuracy in some cases. (M31 Hole Probe Only)
- Return To Original XY: Setting this to TRUE will case the gantry to move to the same X/Y Machine coordinate when the M6 Tool Change was requested. The gantry will remain at SafeZ. (M6 only)
- Valid Tool Check: Setting this to TRUE will direct the M6 Tool Change macro to inspect the requested Tool ID to see if it has already been loaded during the prior operation. If so, a message will be presented to inform that a Tool Change is NOT necessary and operation will then continue. However, if setting is enabled, then a Tool Number is expected and MUST be provided (even if ultimately ignored). If this setting is disabled, then a Tool Number is NOT required, and the M6 Macro may be manually run from the MDI just by typing “M6” (without any tool number). (M6 only)
- Zero XY (Surface Probe): If set to TRUE, the WCS X and Y coordinates will be zero’ed at the location of the Surface Probe operation. If set to FALSE, then the WCS X and Y coordinates will not be modified in any way. If you need to manually zero the WCS X and Y coordinates at some other location other than the location you are Surface Probing, then leave this disabled. (M31 Surface Probe Only)
- Use Full Thickness: Typically used for Surface Probing. If you are setting a Mobile Plate with corner detection fully on top of a work piece (not resting on the shelf), then you will want to set this to true. This tells the M31 Macro to calculate WCS Z zero using the full thickness of the plate (not the shelf thickness). (M31 only)

### **Dynamic Variables (Profile):**

Several variables are maintained/updated inside the active UCCNC profile by the M31 and M6 macros. All variables used/maintained by this macro family can be found in the private “[XYZProbeData]” section of the profile. These are documented here in the event that they may be useful in any way.

- TimeStamp: Date/Time of most recent Probe (M31) or Tool Change (M6) activity.
- WorkXZero: Machine X Coordinate of Workspace origin from last M31 Probe Action.
- WorkYZero: Machine Y Coordinate of Workspace origin from last M31 Probe Action.
- WorkZZero: Machine Z Coordinate of Workspace origin from last M31 Probe Action or last M6 Tool Change (whichever occurred most recently).

- PlateOffset: Z distance between Workspace origin (work piece surface) and the Machine Z Coordinate of the Fixed Plate surface. (Maintained by M31 and referenced by M6).

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